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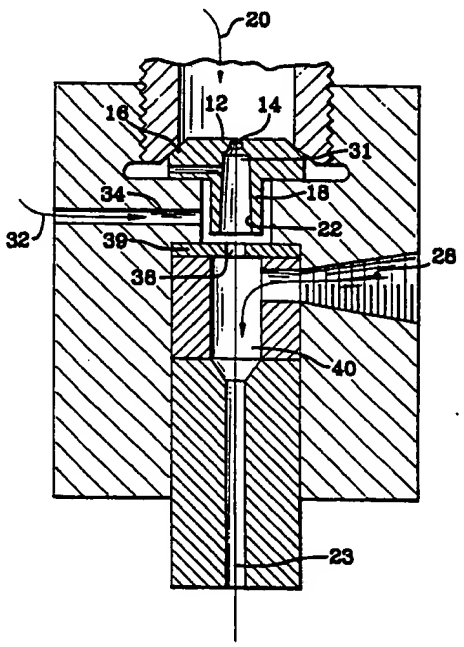
With amended claims

(54) Title: REVERSE FLOW LIMITER FOR FLUID JET NOZZLE

(57) Abstract

An apparatus (10) has a nozzle (12) including a nozzle orifice (14). There is a first chamber (22) adjacent and immediately downstream of the nozzle orifice (14). A first fluid supply (20) which supplies a first fluid is applied to the nozzle assembly wherein the first fluid passes through the orifice which exits downstream into the first chamber (22). A second fluid supply (28) supplies a second fluid, and is located downstream of said first fluid supply (20) in fluid communication with the first fluid supply (20). A flow limiter limits flow of the second fluid supply to the first chamber (22). The flow limiter may be a third fluid supply (32) applied to the first chamber, located intermediate said first and second fluid supplies. The flow limiter may alternatively be a throat formed (38) in a member, which a fluid jet applied by the first fluid supply passes through.



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REVERSE FLOW LIMITER FOR FLUID JET NOZZLE

BACKGROUND OF INVENTION

This invention relates generally to a fluid jet device and more particularly to a device to limit backflow of a second fluid toward the location of introduction of the fluid jet which disrupts the fluid jet, and wears the elements of the fluid jet.

In present fluid jet systems, fluid escaping from the nozzle will create a vacuum. This vacuum will tend to propel particulate matter (especially abrasives, if the system is an abrasive system) towards the nozzle. This will disrupt the fluid jet, as well as damage any part which the particulate contacts.

The foregoing illustrates limitations known to exist in present fluid jet systems. Thus, it is apparent that it would be advantageous to provide an alternative directed to overcoming one or more of the limitations set forth above. Accordingly, a suitable alternative is provided including features more fully disclosed hereinafter.

SUMMARY OF THE INVENTION

In one aspect of the present invention, this is accomplished by providing an apparatus having a nozzle assembly including a nozzle orifice. There is a first chamber adjacent and immediately downstream of the nozzle orifice. A first fluid supply which supplies a first fluid, is applied to the nozzle assembly wherein the first fluid passes through the orifice which exits downstream into the first chamber. A second fluid supply supplies a second fluid and is located

downstream of said first fluid supply. A flow limiter limits flow of the second fluid supply to the first chamber.

The foregoing and other aspects will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawing figures.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

Fig. 1 is a cross sectional view illustrating a prior art embodiment of fluid jet apparatus;

Fig. 2 is a cross sectional side view illustrating an alternative embodiment of fluid jet apparatus with a third fluid supply and member with a throat of the present invention.

Fig. 3. is a cross sectional side view illlustrating an alternative embodiment of fluid jet apparatiu with a third fluid supply and member with a throat of the present invention.

DETAILED DESCRIPTION

In the present disclosure, elements which function identically in different embodiments are provided with identical reference characters.

A fluid jet apparatus is illustrated generally as 10. The fluid jet apparatus may be used in such applications as cutting and cleaning. The fluid jet apparatus 10 includes a nozzle assembly 12. The nozzle assembly 12 may include a nozzle head 16 and a nozzle stem 18. A nozzle orifice 14 is located in the nozzle head 16.

A first fluid supply 20, which supplies a first fluid, is in fluid communication with the nozzle orifice 14. Fluid being discharged through the nozzle orifice 14 from a first fluid supply 20 will enter a first chamber 22 as a fluid jet 23. The fluid jet will tend to disrupt fluid in the first chamber 22, a vacuum 31 will thereby be created in the first chamber 22.

Fluid jet apparatus of this type may be applied to abrasive systems (see Figs. 1 and 2) or to non-abrasive systems (see Fig. 2). In non-abrasive systems, the first chamber 22 is typically in fluid communication with the atmosphere 26. The rush of fluid passing from the atmosphere to the vacuum of relatively lower pressure vacuum 31 may cause disruption of the fluid jet 23.

In abrasive systems a second fluid supply 28, which supplies a second fluid typically contains abrasives, is introduced downstream of the orifice assembly 12. When fluid introduced from the second fluid supply 28 flows to the vacuum 31, not only is the fluid jet 23 disrupted, but often abrasives may come in contact with the first nozzle head 16. This contact by the abrasives will cause unwanted wear, or damage to the above mentioned elements.

Fluid flow from either the atmosphere 26 of the second fluid supply 28 (the atmosphere may be considered as the second fluid supply) to the vacuum 31 will be referred to in this specification as backflow 30 (see Fig. 1). It is desired to limit this backflow as much as possible. A third fluid supply 32 is in fluid communication with the first chamber 22 intermediate the first fluid supply 20 and the second fluid supply 28. The third fluid supply 32 acts to create a pressure cushion which limits the backflow 30.

It is envisioned that the third fluid supply 32 may be applied at several different locations to be effective. Figure 2 illustrates the application of the third fluid supply 32, which may be ambient or pressurized air supply, to the outside of the nozzle stem 18. The left half of the Figure 3 illustrates the application of the third fluid supply through the nozzle head 16. Finally, the right half of Figure 3 illustrates the third fluid supply 32 being applied through

the nozzle stem 18 itself. Either of these embodiments will limit the above mentioned backflow 30. Each of these embodiments may be used in combination with different embodiments.

The third fluid supply 32 may also include a vent 34 to the atmosphere 26. Alternatively, the third fluid supply 32 could communicate with a high pressure source 36.

Reduced throat 38 formed in member 39 may be used in either the abrasive or the non-abrasive systems, to restrict the backflow 30. The reduced throat 38 may provide a barrier between the first chamber 22 and the atmosphere 26, or it may separate the first chamber 22 from a second chamber 40. In all the above mentioned embodiments, passage of the fluid jet 23 is permitted while the backflow 30 is limited.

Using both the reduced throat 38 and the third fluid supply 32 will more effectively reduce the backflow 30 than using either backflow limiter alone. This results from the modifying the flow conditions at the first chamber 22 (see Fig.2), while maintaining a desirable vacuum in the second chamber 40. Since hardly any vacuum exists in the first chamber relative to the second chamber, virtually all fluid in the second fluid supply 28, which is typically an abrasive feed source, will ne diverted in the same direction as the fluid from the first fluid supply 20.

Having described the invention, what is claimed is:

1. An apparatus comprising:

a nozzle assembly including a nozzle orifice;

a first chamber adjacent and immediately downstream of the nozzle orifice;

a first fluid supply which supplies a first fluid, applied to the nozzle assembly wherein the first fluid passes through the orifice, and exits downstream into the first chamber;

a second fluid supply which supplies a second fluid, located downstream of said first fluid supply and in fluid communication with the first fluid supply; and

flow limiting means for limiting flow of the second fluid supply to the first fluid chamber.

2. The apparatus as described in claim 1, wherein the flow limiting means includes a third fluid supply applied to the first chamber, located intermediate said first and second fluid supplies.

3. The apparatus as described in claim 1, wherein the flow limiting means is a throat formed in a member, which a fluid jet applied by the first fluid supply passes through, between said second and third fluid supplies.

4. An apparatus comprising:

a nozzle assembly including a nozzle orifice;

a first chamber adjacent and immediately downstream of the nozzle orifice;

a first fluid supply, which supplies a first fluid, being applied to the nozzle assembly wherein the first fluid passes through the orifice, and exits downstream into the first chamber;

a second fluid supply, located downstream of said first fluid supply and in fluid communication with the first fluid supply; and

a third fluid supply applied to the first chamber, located intermediate said first and second fluid supplies.

5. The apparatus as described in claim 4, wherein the nozzle assembly includes a nozzle head and a nozzle stem.

6. The apparatus as described in claim 5, wherein the third fluid supply is applied outside of the nozzle stem.

7. The apparatus as described in claim 5, wherein the third fluid supply is applied through the nozzle stem.

8. The apparatus as described in claim 5, wherein the third fluid supply is applied through the nozzle stem.

9. The apparatus as described in claim 5, wherein the third fluid supply is in fluid communication with the atmosphere.

10. The apparatus as described in claim 5, wherein the third fluid supply is in fluid communication with a pressure source.

11. The apparatus as described in claim 4, further comprising:

a throat formed in a member, which a fluid jet applied by the first fluid supply passes through, between said second and third supplies.

12. The apparatus as described in claim 4, further comprising:

a second chamber, in fluid communication with said first chamber, which the second contains abrasive particles.

13. The apparatus as described in claim 12, wherein the second fluid supply contains abrasive particles.

14. An apparatus comprising:

a nozzle assembly including a nozzle orifice;

a first chamber adjacent and immediately downstream of the nozzle orifice;

a first fluid supply, which supplies a first fluid, being applied to the nozzle assembly wherein the first fluid passes through the orifice, and exits downstream into the first chamber, wherein the first fluid exiting the orifice has a tendency to create a vacuum gradient in the first chamber;

a second fluid supply which supplies a second fluid, located downstream of said first fluid supply and in fluid communication with the first fluid supply, wherein a backflow has a tendency to be created by the second fluid flowing to the vacuum; and

a third fluid supply applied to the first chamber, located intermediate said first and second fluid supplies for limiting said backflow.

15. The apparatus as described in claim 14, wherein the nozzle assembly includes a nozzle head and a nozzle stem.

16. The apparatus as described in claim 15, wherein the third fluid supply is applied outside of the nozzle head.

17. The apparatus as described in claim 15, wherein the third fluid supply is applied through the nozzle head.

18. The apparatus as described in claim 15, wherein the third fluid supply is applied through the nozzle stem.

19. The apparatus as described in claim 14, wherein the second fluid supply contains abrasive particles.

20. An apparatus comprising:

a nozzle assembly including a nozzle orifice;

a first chamber adjacent and immediately downstream of the nozzle orifice;

a first fluid supply which supplies a first fluid, being applied to the nozzle assembly wherein the first fluid passes through the orifice, and exits downstream into the first chamber;

a second fluid supply which supplies a second fluid, located downstream of said first fluid supply and in fluid communication with the first fluid supply; and

a third fluid supply means creating a fluid cushion in the first chamber, located intermediate said first cushion in the first chamber, located intermediate said first and second fluid supplies, for restricting flow of the second fluid to the first chamber.

21. An apparatus comprising:

a nozzle assembly including a nozzle orifice;

a first chamber adjacent and immediately downstream of the nozzle orifice;

a first fluid supply, which supplies a first fluid, being applied to the nozzle assembly wherein the first fluid passes through the orifice, and exits downstream into the first chamber;

a second fluid supply, located downstream of said first fluid supply and in fluid communication with the first fluid supply; and a throat formed in a member, which fluid jet applied by the first fluid supply passes through, between said second and third fluid supplies.

AMENDED CLAIMS

[received by the International Bureau on 9 October 1992 (09.10.92); original claims 2-4 deleted; original claims 1,11,12 and 14 amended; remaining claims unchanged (4 pages)]

1. An apparatus comprising:

a nozzle assembly including a nozzle orifice;

a first chamber adjacent and immediately downstream of the nozzle orifice;

a first fluid supply which supplies a first fluid to the nozzle assembly wherein the first fluid passes through the orifice, and exits downstream into the first chamber, said first fluid passing through the nozzle into the first chamber is capable of creating a partial vacuum in the first chamber;

a second fluid supply which supplies a second fluid, the second fluid supply being located downstream of said first fluid supply and in fluid communication with the first fluid supply; and

flow limiting means, consisting of a third fluid supply which supplies a third fluid and is located intermediate said first fluid supply and said second fluid supply for limiting disruption of said first fluid entering the first chamber by substantially equalizing the partial vacuum thereby reducing flow of said third fluid into said first chamber.

5. The apparatus as described in claim 1, wherein the nozzle assembly includes a nozzle head and a nozzle stem.

6. The apparatus as described in claim 5, wherein the third fluid supply is applied outside of the nozzle stem.

7. The apparatus as described in claim 5, wherein the third fluid supply is applied through the nozzle stem.

8. The apparatus as described in claim 5, wherein the third fluid supply is applied through the nozzle stem.

9. The apparatus as described in claim 5, wherein the third fluid supply is in fluid communication with the atmosphere.

10. The apparatus as described in claim 5, wherein the third fluid supply is in fluid communication with a pressure source.

11. The apparatus as described in claim 1, further comprising:

a throat formed in a member, which a fluid jet applied by the first fluid supply passes through, between said second and third supplies.

12. The apparatus as described in claim 1, further comprising:

a second chamber, in fluid communication with said first chamber, which the second contains abrasive particles.

13. The apparatus as described in claim 12, wherein the second fluid supply contains abrasive particles.

14. An apparatus comprising:

a nozzle assembly including a nozzle orifice;

a first chamber adjacent and immediately downstream of the nozzle orifice;

a first fluid supply, which supplies a first fluid, being applied to the nozzle assembly wherein the first fluid passes through the orifice and exits downstream into the first chamber, wherein the first fluid exiting the orifice has a tendency to create a vacuum gradient in the first chamber;

a second fluid supply which supplies a second fluid, located downstream of said first fluid supply and in fluid communication with the first fluid supply, wherein a backflow has a tendency to be created by said second fluid flowing into the first chamber by said vacuum; and

a third fluid supply, which supplies a third fluid, the third fluid being applied intermediate said first and second fluid supplies for limiting said backflow by substantially equalizing said vacuum gradient.

15. The apparatus as described in claim 14, wherein the nozzle assembly includes a nozzle head and a nozzle stem.

16. The apparatus as described in claim 15, wherein the third fluid supply is applied outside of the nozzle head.

17. The apparatus as described in claim 15, wherein the third fluid supply is applied through the nozzle head.

18. The apparatus as described in claim 15, wherein the third fluid supply is applied through the nozzle stem.

19. The apparatus as described in claim 14, wherein the second fluid supply contains abrasive particles.

20. An apparatus comprising:

a nozzle assembly including a nozzle orifice;

a first chamber adjacent and immediately downstream of the nozzle orifice;

a first fluid supply which supplies a first fluid, being applied to the nozzle assembly wherein the first fluid passes through the orifice, and exits downstream into the first chamber;

a second fluid supply which supplies a second fluid, located downstream of said first fluid supply and in fluid communication with the first fluid supply; and

a third fluid supply means creating a fluid cushion in the first chamber, located intermediate said first cushion in the first chamber, located intermediate said first and second fluid supplies, for restricting flow of the second fluid to the first chamber.

21. An apparatus comprising:

a nozzle assembly including a nozzle orifice;

a first chamber adjacent and immediately downstream of the nozzle orifice;

a first fluid supply, which supplies a first fluid, being applied to the nozzle assembly wherein the first fluid passes through the orifice, and exits downstream into the first chamber;

a second fluid supply, located downstream of said first fluid supply and in fluid communication with the first fluid supply; and

a throat formed in a member, which fluid jet applied by the first fluid supply passes through, between said second and third fluid supplies.

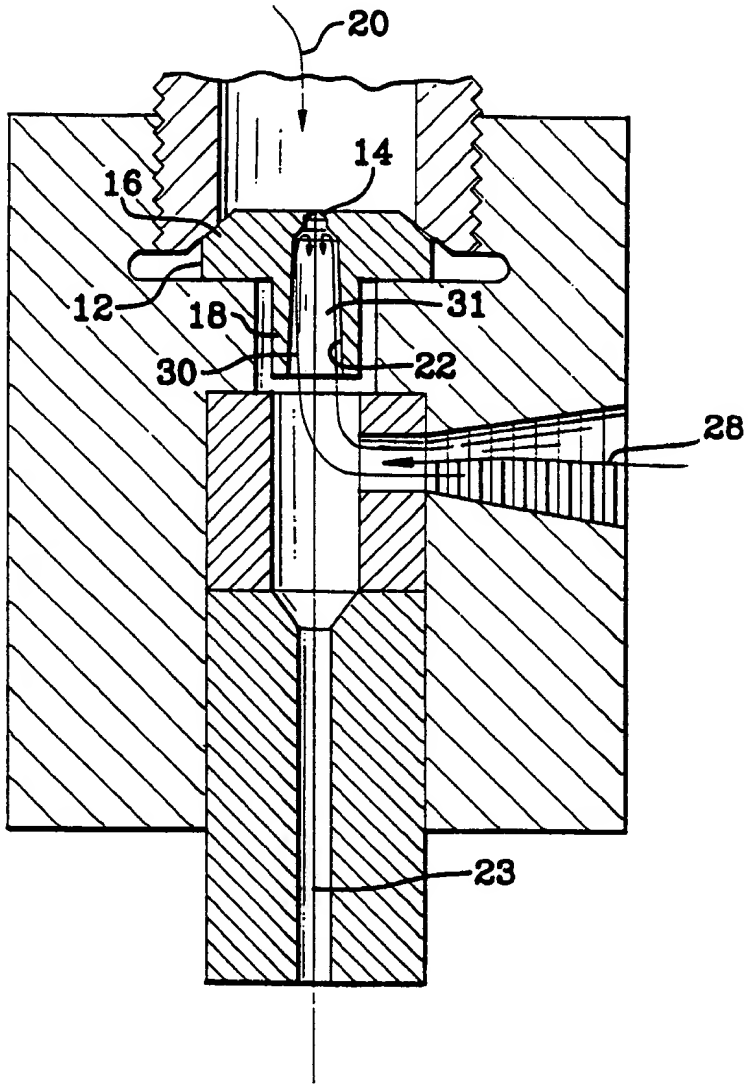

FIG. 1 (PRIOR ART)

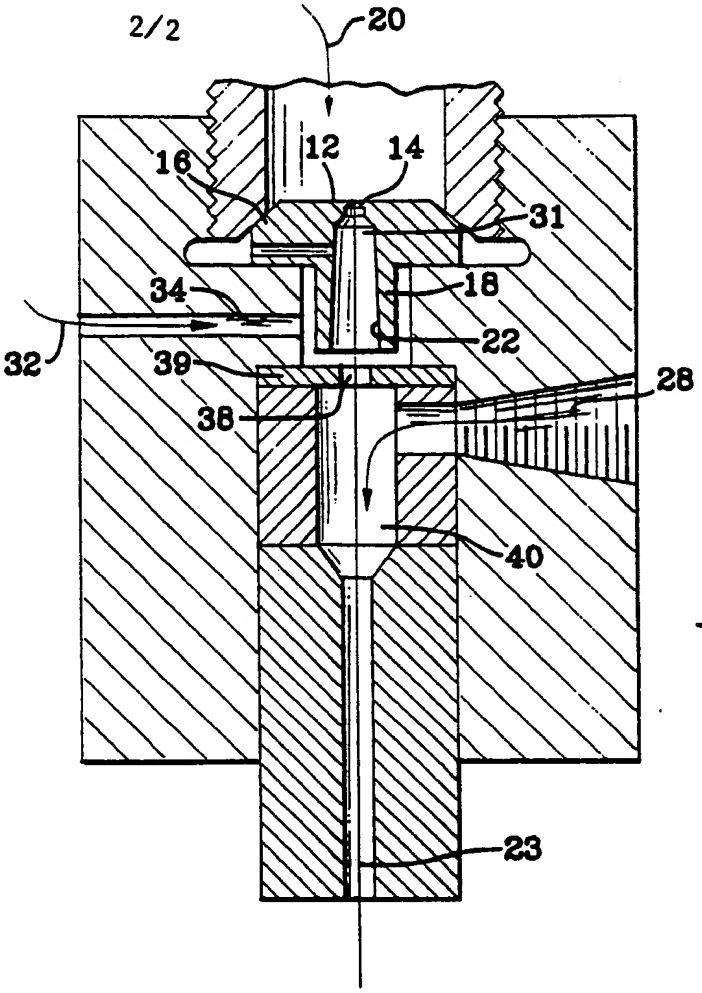

FIG. 2

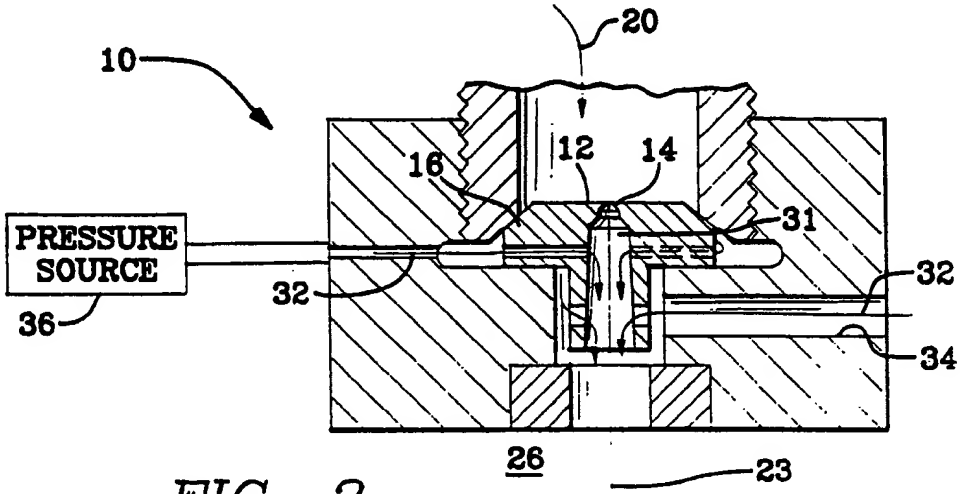

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 92/03466

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B05B7/14; B24C5/04

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B05B ; B24C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	EP,A,0 391 500 (FLOW INTERNATIONAL CORPORATION) 10 October 1990 see column 6, line 3 - column 7, line 4; figure 2	1-5,7-9, 11-15, 17-21
X	US,A,3 055 149 (LUCE) 23 March 1959 see column 2, line 57 - line 66; figure 2	1,2,4-6, 9,12-16, 19,20

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
28 JULY 1992	07.08.92
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	JUGUET J.M.

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 9203466 SA 60996

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 28/07/92 The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0391500	10-10-90	US-A- 4951429 JP-A- 3003775	28-08-90 09-01-91
US-A-3055149		None	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82